

[0318] What is claimed is:

1 1. A computer-implemented method of discovering relationships between  
2 items, comprising:  
3 accepting item selections from a plurality of users;  
4 generating a log for each user, each log containing identifiers for the user's  
5 item selections;  
6 accepting a query including at least one query item identifier;  
7 scoring the user logs, responsive to a degree of occurrence of the at least  
8 one query item identifier in the user logs, to generate user log  
9 scores; and  
10 determining at least one result item, responsive to a degree of occurrence  
11 in at least a subset of the scored user logs.

1 2. The computer-implemented method of claim 1, wherein a significance  
2 of the occurrence is determined by a log likelihood ratio analysis and the deter-  
3 mined result is responsive to the determined significance.

1 3. The computer-implemented method of claim 1, wherein a significance  
2 of the occurrence is determined by a substantial equivalent of a log likelihood  
3 ratio analysis and the determined result is responsive to the determined signifi-  
4 cance.

1           4. The computer-implemented method of claim 1, wherein each item is a  
2 video track and wherein accepting item selections comprises determining which  
3 tracks are selected for playback.

1           5. The computer-implemented method of claim 1, wherein each item is a  
2 music track and wherein accepting item selections comprises determining which  
3 tracks are selected for playback.

1           6. The computer-implemented method of claim 5, further comprising:  
2 generating a track list containing an identifier for each determined result  
3 item comprising a music track.

1           7. The computer-implemented method of claim 6, further comprising:  
2 deleting from the track list at least one identifier corresponding to a music  
3 track already selected by the user.

1           8. The computer-implemented method of claim 6, further comprising:  
2 playing the music tracks specified by the generated track list.

1           9. The computer-implemented method of claim 5, further comprising:  
2 accepting a format schedule specifying music track categories for time pe-  
3 riods; and

4 generating a track list conforming to the format schedule and containing  
5 an identifier for each determined result item comprising a music  
6 track.

1 10. The computer-implemented method of claim 5, wherein scoring the  
2 user logs comprises determining a degree of occurrence in each user log of at  
3 least one music track identified by the query item identifier.

1 11. The computer-implemented method of claim 5, wherein scoring the  
2 user logs comprises determining a degree of occurrence in each user log of at  
3 least one music track associated with an artist identified by the query item identi-  
4 fier.

1 12. The computer-implemented method of claim 1, wherein accepting item  
2 selections comprises receiving input provided by a user via a web page.

1 13. The computer-implemented method of claim 1, wherein accepting item  
2 selections comprises receiving input specifying an item purchase by a user.

1 14. The computer-implemented method of claim 1, further comprising,  
2 prior to determining the at least one result item, defining the subset of the scored  
3 user logs responsive to the user log scores.

1           15. The computer-implemented method of claim 1, further comprising:  
2           monitoring user behavior with respect to the selected items; and  
3           adjusting the user log responsive to the monitored user behavior.

1           16. The computer-implemented method of claim 15, wherein monitoring  
2   user behavior comprises at least one selected from the group consisting of:  
3           detecting user input requesting that a selected item be repeated;  
4           detecting user input requesting that a selected item be skipped;  
5           detecting user input specifying a volume change; and  
6           detecting user input specifying that a selected item be muted.

1           17. The computer-implemented method of claim 1, wherein accepting item  
2   selections comprises receiving input provided by a user via an application for  
3   playing tracks.

1           18. The computer-implemented method of claim 1, wherein accepting a  
2   query comprises receiving a user log containing identifiers for a user's item selec-  
3   tions.

1           19. The computer-implemented method of claim 1, wherein accepting a  
2   query comprises receiving a first search term, the method further comprising:

3 generating a second search term containing an identifier for each deter-  
4 mined result item.

1 20. The computer-implemented method of claim 19, further comprising at  
2 least one of:

3 providing the second search term as input for a search engine; and  
4 adding the second search term to a searchable portion of a document as-  
5 sociated with the first search term.

1 21. The computer-implemented method of claim 1, further comprising:  
2 periodically uploading the generated log.

1 22. The computer-implemented method of claim 1, further comprising:  
2 outputting an advertisement relating to the determined at least one result  
3 item.

1 23. The computer-implemented method of claim 22, wherein outputting  
2 an advertisement comprises displaying at least one selected from the group con-  
3 sisting of:

4 a web page;  
5 a banner;  
6 a portion of a web page; and  
7 an animation.

1        24. The computer-implemented method of claim 1, further comprising:  
2        outputting a notification relating to the determined at least one result  
3        item.

1        25. The computer-implemented method of claim 24, wherein outputting a  
2        notification comprises displaying a web page.

1        26. The computer-implemented method of claim 24, wherein outputting a  
2        notification comprises sending a communication to a user.

1        27. The computer-implemented method of claim 26, wherein sending a  
2        communication to a user comprises at least one selected from the group consist-  
3        ing of:

4        transmitting an electronic mail message to the user;  
5        telephoning the user; and  
6        sending a direct mail item to the user.

1        28. The computer-implemented method of claim 1, wherein the deter-  
2        mined result is responsive to a significance of the occurrence of the item in at  
3        least a subset of the scored user logs, and wherein the significance is determined  
4        by a log likelihood ratio analysis submethod comprising:  
5        determining a total number of user logs N;

6 determining a number of user logs  $N_1$  in a subset of user logs;  
 7 determining a number of user logs  $N_2$  not in the subset of user logs;  
 8 determining a number of user logs  $k_{11}$  in the subset that include the item;  
 9 determining a number of user logs  $k_{12}$  not in the subset that include the  
 10 item;  
 11 determining a number of user logs  $k_{21} = N_1 - k_{11}$  in the subset that do not  
 12 include the item;  
 13 determining a number of user logs  $k_{22} = N_2 - k_{12}$  not in the subset that do  
 14 not include the item;  
 15 and determining a log likelihood ratio for the item.

1 29. The computer-implemented method of claim 28, wherein the log like-  
 2 lihood ratio is defined as:

$$\sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

$$\text{where: } \pi_{ij} = \frac{k_{ij}}{N_j}, \mu_j = \sum_i \frac{k_{ij}}{N}.$$

1 30. The computer-implemented method of claim 29, further comprising:  
 2 adjusting at least one of the  $k_{ij}$  values responsive to at least one selected  
 3 from the group consisting of:  
 4 the number of occurrences of the item in a user log;

5 the logarithm of the number of occurrences of the item in a user  
6 log;  
7 the number of occurrences of the item in all user logs;  
8 the logarithm of the total number of users divided by the number  
9 of users who have selected the item; and  
10 a normalizing factor.

1 31. The computer-implemented method of claim 30, wherein the normal-  
2 izing factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  is a weight based on the number of occur-  
3 rences of the item in all user logs and  $W_{ij}$  is a weight based on the number of oc-  
4 currences of the item in a particular user log.

1 32. The computer-implemented method of claim 1, further comprising:  
2 deleting from the determined at least one result item any result items al-  
3 ready selected by a user associated with the query.

1 33. The computer-implemented method of claim 1, further comprising:  
2 ranking the at least one result item responsive to the degree of signifi-  
3 cance.

1 34. A computer-implemented method of discovering a relationship be-  
2 tween a first item and a second item, comprising:



3 determining a total number of item groups  $N$ ;  
 4 determining a number of item groups  $N_1$  in a subset of item groups, the  
 5 subset of item groups being defined as including those item  
 6 groups that contain a second item;  
 7 determining a number of item groups  $N_2$  not in the subset of item groups;  
 8 determining a number of item groups  $k_{11}$  in the subset that contain the  
 9 first item;  
 10 determining a number of item groups  $k_{12}$  not in the subset that contain the  
 11 first item;  
 12 determining a number of item groups  $k_{21} = N_1 - k_{11}$  in the subset that do  
 13 not contain the first item;  
 14 determining a number of item groups  $k_{22} = N_2 - k_{12}$  not in the subset that  
 15 do not contain the first item;  
 16 and determining a log likelihood ratio.

1 35. The computer-implemented method of claim 34, wherein the log like-  
 2 lihood ratio is defined as:

$$\sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

$$\text{where: } \pi_{ij} = \frac{k_{ij}}{N_j}, \mu_j = \sum_i \frac{k_{ij}}{N}.$$

1 36. The computer-implemented method of claim 35, wherein each item  
2 group comprises a document.

1 37. The computer-implemented method of claim 35, further comprising:  
2 adjusting at least one of the  $k_{ij}$  values responsive to at least one selected  
3 from the group consisting of:  
4 the number of occurrences of the item in a document;  
5 the logarithm of the number of occurrences of the item in a docu-  
6 ment;  
7 the number of occurrences of the item in all documents;  
8 the logarithm of the total number of documents divided by the  
9 number of documents that include the item; and  
10 a normalizing factor.

1 38. The computer-implemented method of claim 37, wherein the normal-  
2 izing factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  represents the number of occurrences of  
3 the item in all documents and  $W_{ij}$  represents the number of occurrences of the  
4 item in a particular document.

1 39. A system for discovering relationships among items, comprising:  
2 a user interface for accepting item selections from a plurality of users;

3 at least one log database, coupled to the user interface, for storing a log for  
4 each user, each log containing identifiers for the user's item  
5 selections;  
6 a query input device for accepting a query including at least one query  
7 item identifier; and  
8 a recommendation engine, coupled to the log database and to the query  
9 input device, for scoring the user logs, responsive to a degree of  
10 occurrence, to generate user log scores, and for determining at  
11 least one result item, responsive to a degree of occurrence in at  
12 least a subset of the scored user logs.

1 40. The system of claim 39, wherein the significance of the occurrence is  
2 determined by a log likelihood ratio analysis and the recommendation engine  
3 determines the at least one result item responsive to the determined significance.

1 41. The system of claim 39, wherein the significance of the occurrence is  
2 determined by a substantial equivalent of a log likelihood ratio analysis and  
3 wherein the recommendation engine determines the at least one result item re-  
4 sponsive to the determined significance.

1           42. The system of claim 39, wherein each item is a video track and wherein  
2     the user interface accepts item selections by determining which tracks are se-  
3     lected for playback.

1           43. The system of claim 39, wherein the user interface accepts item selec-  
2     tions by determining which tracks are selected for purchase.

1           44. The system of claim 39, wherein each item is a music track and  
2     wherein the user interface accepts item selections by determining which tracks  
3     are selected for playback.

1           45. The system of claim 44, wherein the user interface comprises an online  
2     jukebox.

1           46. The system of claim 45, wherein the online jukebox monitors user be-  
2     havior with respect to the selected items and adjusts the user log scores respon-  
3     sive to the monitored user behavior.

1           47. The system of claim 46, wherein the online jukebox monitors user be-  
2     havior by detecting at least one selected from the group consisting of:  
3         user input requesting that a selected item be repeated; and  
4         user input requesting that a selected item be skipped; and

5 user input specifying a volume change; and  
6 user input specifying that a selected item be muted.

1 48. The system of claim 47, further comprising:  
2 a track list generator, coupled to the recommendation engine, for generat-  
3 ing a track list containing an identifier for each determined re-  
4 sult item comprising a music track.

1 49. The system of claim 44, further comprising:  
2 a music player, coupled to the track list generator, for playing the music  
3 tracks specified by the generated track list.

1 50. The system of claim 44, further comprising:  
2 a format scheduler, for accepting a format schedule specifying music track  
3 categories for time periods; and  
4 a track list generator, coupled to the recommendation engine and to the  
5 format scheduler, for generating a track list conforming to the  
6 format schedule and containing an identifier for each deter-  
7 mined result item comprising a music track.

1 51. The system of claim 39, wherein the query input device receives a user  
2 log containing identifiers for a user's item selections.

1           52. The system of claim 39, wherein the query input device receives a first  
2 search term, the system further comprising:

3           a search term generator, coupled to the recommendation engine, for gen-  
4           erating a second search term containing an identifier for each  
5           determined result item and for providing the second search  
6           term as input for a search engine.

1           53. The system of claim 39, wherein the query input device receives a first  
2 search term, the system further comprising:

3           a search term generator, coupled to the recommendation engine, for gen-  
4           erating a second search term containing an identifier for each  
5           determined result item and for providing the second search  
6           term to be added to a searchable portion of a document associ-  
7           ated with the first search term.

1           54. The system of claim 39, further comprising:  
2           an advertisement output device, coupled to the recommendation engine,  
3           for outputting an advertisement relating to the determined at  
4           least one result item.

1           55. The system of claim 54, wherein the advertisement output device dis-  
2 plays at least one selected from the group consisting of:

3 a web page;  
4 a banner;  
5 a portion of a web page; and  
6 an animation.

1 56. The system of claim 39, further comprising:  
2 a notification output, coupled to the recommendation engine, for output-  
3 ting a notification relating to the determined at least one result  
4 item.

1 57. The system of claim 56, wherein the notification output device displays  
2 at least one selected from the group consisting of:  
3 a web page;  
4 a banner;  
5 a portion of a web page; and  
6 an animation.

1 58. The system of claim 56, wherein the notification output device sends a  
2 communication to a user.

1 59. A computer-readable medium comprising computer-readable code for  
2 discovering relationships between items, comprising:

3 computer-readable code adapted to accept item selections from a plurality  
4 of users;  
5 computer-readable code adapted to generate a log for each user, each log  
6 containing identifiers for the user's item selections;  
7 computer-readable code adapted to accept a query including at least one  
8 query item identifier;  
9 computer-readable code adapted to score the user logs, responsive to a  
10 degree of occurrence of the at least one query item identifier in  
11 the user logs, to generate user log scores; and  
12 computer-readable code adapted to determine at least one result item, re-  
13 sponsive to a degree of occurrence in at least a subset of the  
14 scored user logs.

1 60. The computer-readable medium of claim 59, wherein a significance of  
2 the occurrence is determined by a log likelihood ratio analysis and the deter-  
3 mined result is responsive to the determined significance.

1 61. The computer-readable medium of claim 59, wherein a significance of  
2 the occurrence is determined by a substantial equivalent of a log likelihood ratio  
3 analysis and the determined result is responsive to the determined significance.



1           62. The computer-readable medium of claim 59, wherein each item is a  
2 video track and wherein the computer-readable code adapted to accept item se-  
3 lections comprises computer-readable code adapted to determine which tracks  
4 are selected for playback.

1           63. The computer-readable medium of claim 59, wherein each item is a  
2 music track and wherein the computer-readable code adapted to accept item se-  
3 lections comprises computer-readable code adapted to determine which tracks  
4 are selected for playback.

1           64. The computer-readable medium of claim 63, further comprising:  
2 computer-readable code adapted to generate a track list containing an  
3 identifier for each determined result item comprising a music  
4 track.

1           65. The computer-readable medium of claim 64, further comprising:  
2 computer-readable code adapted to delete from the track list at least one  
3 identifier corresponding to a music track already selected by the  
4 user.

1           66. The computer-readable medium of claim 64, further comprising:

2 computer-readable code adapted to play the music tracks specified by the  
3 generated track list.

1 67. The computer-readable medium of claim 63, further comprising:  
2 computer-readable code adapted to accept a format schedule specifying  
3 music track categories for time periods; and  
4 computer-readable code adapted to generate a track list conforming to the  
5 format schedule and containing an identifier for each deter-  
6 mined result item comprising a music track.

1 68. The computer-readable medium of claim 63, wherein the computer-  
2 readable code adapted to score the user logs comprises computer-readable code  
3 adapted to determine a degree of occurrence in each user log of at least one mu-  
4 sic track identified by the query item identifier.

1 69. The computer-readable medium of claim 63, wherein the computer-  
2 readable code adapted to score the user logs comprises computer-readable code  
3 adapted to determine a degree of occurrence in each user log of at least one mu-  
4 sic track associated with an artist identified by the query item identifier.

1 70. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept item selections comprises computer-readable  
3 code adapted to receive input provided by a user via a web page.

1           71. The computer-readable medium of claim 59, wherein the computer-  
2     readable code adapted to accept item selections comprises computer-readable  
3     code adapted to receive input specifying an item purchase by a user.

1           72. The computer-readable medium of claim 59, further comprising, com-  
2     puter-readable code adapted to, prior to determine the at least one result item,  
3     define the subset of the scored user logs responsive to the user log scores.

1           73. The computer-readable medium of claim 59, further comprising:  
2     computer-readable code adapted to monitor user behavior with respect to  
3                 the selected items; and  
4     computer-readable code adapted to adjust the user log scores responsive  
5                 to the monitored user behavior.

1           74. The computer-readable medium of claim 73, wherein the computer-  
2     readable code adapted to monitor user behavior comprises at least one selected  
3     from the group consisting of:  
4                 computer-readable code adapted to detect user input requesting that a se-  
5                         lected item be repeated;  
6                 computer-readable code adapted to detect user input requesting that a se-  
7                         lected item be skipped;

8 computer-readable code adapted to detect user input specifying a volume  
9 change; and  
10 computer-readable code adapted to detect user input specifying that a se-  
11 lected item be muted.

1 75. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept item selections comprises computer-readable  
3 code adapted to receive input provided by a user via an application for playing  
4 tracks.

1 76. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept a query comprises computer-readable code  
3 adapted to receive a user log containing identifiers for a user's item selections.

1 77. The computer-readable medium of claim 59, wherein the computer-  
2 readable code adapted to accept a query comprises computer-readable code  
3 adapted to receive a first search term, the computer-readable medium further  
4 comprising:

5 computer-readable code adapted to generate a second search term con-  
6 taining an identifier for each determined result item.

1 78. The computer-readable medium of claim 77, further comprising at  
2 least one of:

3 computer-readable code adapted to provide the second search term as in-  
4 put for a search engine; and  
5 computer-readable code adapted to add the second search term to a  
6 searchable portion of a document associated with the first  
7 search term.

1 79. The computer-readable medium of claim 59, further comprising:  
2 computer-readable code adapted to periodically upload the generated log.

1 80. The computer-readable medium of claim 59, further comprising:  
2 computer-readable code adapted to output an advertisement relating to  
3 the determined at least one result item.

1 81. The computer-readable medium of claim 80, wherein the computer-  
2 readable code adapted to output an advertisement comprises computer-readable  
3 code adapted to display at least one selected from the group consisting of:  
4 a web page;  
5 a banner;  
6 a portion of a web page; and  
7 an animation.

1 82. The computer-readable medium of claim 59, further comprising:

2 computer-readable code adapted to output a notification relating to the  
3 determined at least one result item.

1 83. The computer-readable medium of claim 82, wherein the computer-  
2 readable code adapted to output a notification comprises computer-readable  
3 code adapted to display a web page.

1 84. The computer-readable medium of claim 82, wherein the computer-  
2 readable code adapted to output a notification comprises computer-readable  
3 code adapted to send a communication to a user.

1 85. The computer-readable medium of claim 84, wherein the computer-  
2 readable code adapted to send a communication to a user comprises at least one  
3 selected from the group consisting of:

4 computer-readable code adapted to transmit an electronic mail message to  
5 the user;

6 computer-readable code adapted to telephone the user; and

7 computer-readable code adapted to send a direct mail item to the user.

1 86. The computer-readable medium of claim 59, wherein the determined  
2 result is responsive to a significance of the occurrence of the item in at least a  
3 subset of the scored user logs, and wherein the computer-readable code adapted  
4 to determine a binomial log likelihood ratio for an item comprises computer-

5 readable code adapted to determine the result by a log likelihood ratio analysis  
6 submethod.

1 87. The computer-readable medium of claim 86, wherein the computer-  
2 readable code adapted to determine the result by a log likelihood ratio analysis  
3 submethod comprises:

4 computer-readable code adapted to determine a total number of users  $N$ ;

5 computer-readable code adapted to determine a number of users  $N_1$  in a  
6 subset of users;

7 computer-readable code adapted to determine a number of users  $N_2$  not in  
8 the subset of users;

9 computer-readable code adapted to determine a number of users  $k_{11}$  in the  
10 subset that selected the item;

11 computer-readable code adapted to determine a number of users  $k_{12}$  not  
12 in the subset that selected the item;

13 computer-readable code adapted to determine a number of users  $k_{21} = N_1$   
14 -  $k_{11}$  in the subset that did not select the item;

15 computer-readable code adapted to determine a number of users  $k_{22} = N_2$   
16 -  $k_{12}$  not in the subset that did not select the item; and

17 computer-readable code adapted to determine a log likelihood ratio for  
18 the item.

1           88. The computer-readable medium of claim 87, wherein the log likeli-  
2   hood ratio is defined as:

3           
$$\sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

4           where:  $\pi_{ij} = \frac{k_{ij}}{N_j}$ ,  $\mu_j = \sum_i \frac{k_{ij}}{N}$ .

1           89. The computer-readable medium of claim 59, wherein the computer-  
2   readable code adapted to determine the result by a log likelihood ratio analysis  
3   submethod further comprises:

4           computer-readable code adapted to adjust at least one of the  $n_{ij}$  values re-  
5           sponsive to at least one selected from the group consisting of:  
6           the number of occurrences of the item in a user log;  
7           the logarithm of the number of occurrences of the item in a user  
8           log;  
9           the number of occurrences of the item in all user logs;  
10          the logarithm of the total number of users divided by the number  
11          of users who have selected the item; and  
12          a normalizing factor.



1           90. The computer-readable medium of claim 89, wherein the normalizing  
2 factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  is a weight based on the number of occurrences  
3 of the item in all user logs and  $W_{ij}$  is a weight based on the number of occur-  
4 rences of the item in a particular user log.

1           91. The computer-readable medium of claim 59, further comprising:  
2 computer-readable code adapted to delete from the determined at least  
3 one result item any result items already selected by a user asso-  
4 ciated with the query.

1           92. The computer-readable medium of claim 59, further comprising:  
2 computer-readable code adapted to rank the at least one result item re-  
3 sponsive to the degree of significance.

1           93. A computer-readable medium comprising computer-readable code for  
2 discovering a relationship between a first item and a second item, comprising:  
3 computer-readable code adapted to determine a total number of item  
4 groups N;  
5 computer-readable code adapted to determine a number of item groups  
6  $N_1$  in a subset of item groups, the subset of item groups being

7 defined as including those item groups that contain a second  
8 item;  
9 computer-readable code adapted to determine a number of item groups  
10  $N_2$  not in the subset of item groups;  
11 computer-readable code adapted to determine a number of item groups  
12  $k_{11}$  in the subset that contain the first item;  
13 computer-readable code adapted to determine a number of item groups  
14  $k_{12}$  not in the subset that contain the first item;  
15 computer-readable code adapted to determine a number of item groups  
16  $k_{21} = N_1 - k_{11}$  in the subset that do not contain the first item;  
17 computer-readable code adapted to determine a number of item groups  
18  $k_{22} = N_2 - k_{12}$  not in the subset that do not contain the first item;  
19 and  
20 computer-readable code adapted to determine a log likelihood ratio.

1 94. The computer-readable medium of claim 93, wherein the log likeli-  
2 hood ratio is defined as:

$$3 \quad \sum k_{ij} \log \frac{\pi_{ij}}{\mu_j}$$

$$4 \quad \text{where: } \pi_{ij} = \frac{k_{ij}}{N_j}, \mu_j = \sum_i \frac{k_{ij}}{N}.$$

1           95. The computer-readable medium of claim 93, wherein each item group  
2 comprises a document.

1           96. The computer-readable medium of claim 93, further comprising:  
2 computer-readable code adapted to adjust at least one of the  $k_{ij}$  values re-  
3 sponsive to at least one selected from the group consisting of:  
4 the number of occurrences of the item in a document;  
5 the logarithm of the number of occurrences of the item in a docu-  
6 ment;  
7 the number of occurrences of the item in all documents;  
8 the logarithm of the total number of documents divided by the  
9 number of documents that include the item; and  
10 a normalizing factor.

1           97. The computer-readable medium of claim 96, wherein the normalizing  
2 factor is  $\frac{1}{\sqrt{\sum (S_j W_{ij})^2}}$ , where  $S_j$  represents the number of occurrences of the item  
3 in all documents and  $W_{ij}$  represents the number of occurrences of the item in a  
4 particular document.